National Institute of Environmental Health Sciences

Geo-additive modelling of malaria in Burundi

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Abstract:

Background: Malaria is a major public health issue in Burundi in terms of both morbidity and mortality, with around 2.5 million clinical cases and more than 15,000 deaths each year. It is still the single main cause of mortality in pregnant women and children below five years of age. Because of the severe health and economic burden of malaria, there is still a growing need for methods that will help to understand the influencing factors. Several studies/researches have been done on the subject yielding different results as which factors are most responsible for the increase in malaria transmission. This paper considers the modelling of the dependence of malaria cases on spatial determinants and climatic covariates including rainfall, temperature and humidity in Burundi. Methods: The analysis carried out in this work exploits real monthly data collected in the area of Burundi over 12 years (1996-2007). Semi-parametric regression models are used. The spatial analysis is based on a geo-additive model using provinces as the geographic units of study. The spatial effect is split into structured (correlated) and unstructured (uncorrelated) components. Inference is fully Bayesian and uses Markov chain Monte Carlo techniques. The effects of the continuous covariates are modelled by cubic p-splines with 20 equidistant knots and second order random walk penalty. For the spatially correlated effect, Markov random field prior is chosen. The spatially uncorrelated effects are assumed to be i.i.d. Gaussian. The effects of climatic covariates and the effects of other spatial determinants are estimated simultaneously in a unified regression framework. Results: The results obtained from the proposed model suggest that although malaria incidence in a given month is strongly positively associated with the minimum temperature of the previous months, regional patterns of malaria that are related to factors other than climatic variables have been identified, without being able to explain them. Conclusions: In this paper, semiparametric models are used to model the effects of both climatic covariates and spatial effects on malaria distribution in Burundi. The results obtained from the proposed models suggest a strong positive association between malaria incidence in a given month and the minimum temperature of the previous month. From the spatial effects, important spatial patterns of malaria that are related to factors other than climatic variables are identified. Potential explanations (factors) could be related to socio-economic conditions, food shortage, limited access to health care service, precarious housing, promiscuity, poor hygienic conditions, limited access to drinking water, land use (rice paddies for example), displacement of the population (due to armed conflicts).

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Resource Description

Early Warning System:

resource focus on systems used to warn populations of high temperatures, extreme weather, or other

elements of climate change to prevent harm to health

A focus of content

Exposure :

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Meteorological Factors, Precipitation, Temperature

Temperature: Fluctuations

Geographic Feature:

resource focuses on specific type of geography

None or Unspecified

Geographic Location:

resource focuses on specific location

Non-United States

Non-United States: Africa

African Region/Country: African Country

Other African Country: Burundi

Health Impact:

specification of health effect or disease related to climate change exposure

Infectious Disease

Infectious Disease: Vectorborne Disease

Vectorborne Disease: Mosquito-borne Disease

Mosquito-borne Disease: Malaria

Mitigation/Adaptation:

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology:

type of model used or methodology development is a focus of resource

Outcome Change Prediction

Population of Concern: A focus of content

Resource Type:

format or standard characteristic of resource

Research Article

Timescale: ☒

time period studied

Short-Term (

Vulnerability/Impact Assessment: ☒

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content